Hart Observation Well
Near Connell, Washington

July, 1984

State of Washington
John Spellman
Governor

OFFICE REPORT #ER841

Department of Ecology
Donald W. Moos
Director

HART OBSERVATION WELL

NEAR CONNELL, WASHINGTON

OFFICE REPORT #ER841

THEODORE M. OLSON, P. E.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
OLYMPIA, WASHINGTON 98504

JULY 1984

TABLE OF CONTENTS

ILLUSTRATIONS

ABSTRACT

The 1,045-foot deep Hart observation well was drilled in 1969 with the intent of using the well for irrigation. However, during drilling it became apparent that the production capability of the well was so limited that an aquifer test was not justified and the well was subsequently abandoned.

Acquisition of the well was part of the ongoing Washington Department of Ecology and United States Geological Survey (USGS) program to monitor ground water levels in eastern Washington. This well is situated approximately 7 miles southeast of the largest ground water pumping center in eastern Washington.

The well penetrates the Wanapum and Grande Ronde basalts. Six piezometers were installed to allow measurement of water levels in the six aquifers penetrated by the well. To date, the water levels in the near surface piezometers appear to reflect climatic changes in precipitation, whereas the deeper piezometers reflect a delayed response to deep irrigation well withdrawals.

INTRODUCTION

GENERAL STATEMENT

This report describes the Hart observation well which was acquired to provide data on stratigraphy and for the measurement of ground water level fluctuations near an area which is intensively irrigated by wells in the south central part of eastern Washington.

This well is one of 17 test/observation wells in eastern Washington (Fig. 1) which were constructed to identify geologic horizons and aquifers, with some wells fitted with piezometers for monitoring water level fluctuations. The test/observation well program was designed to assist the Washington Department of Ecology (WDOE) in the management and appropriation of public ground waters of the state.

This research program is financed jointly by the U.S. Geological Survey (USGS) and WDOE and is part of a continuing cooperative program to conduct surface and ground water resource investigations in Washington.

BACKGROUND

Major developments for ground water irrigation of cereal grain crops in eastern Washington began in the late 1950s. By the mid 1960s, annual ground water withdrawals for irrigation had increased dramatically and ground water level declines were noted in local areas of concentrated pumping.

The WDOE ground water level monitoring program includes approximately 500 wells that have been measured periodically since 1967. The program includes monitoring public and private wells, drilling of test/observation wells, and obtaining easements for use of abandoned wells.

The USGS designs and contracts the piezometer installation as their portion of the cooperative WDOE/USGS program.

The agreement between the landowner and the USGS for use of the well is in effect until July 1990, at which time it can be extended or terminated.

LOCATION OF OBSERVATION WELL

The Hart observation well is located approximately 6 miles northeast of Connell (Fig. 2). The specific location is 815 feet east of the west quarter corner of Section 35, being within the SW¼SE¼SW¼NW¼ of Section 35, T. 15 N., R. 32 E.W.M., Adams County, Washington. Land surface elevation at the well collar is 1,242 feet above mean sea level. The latitude is 46°44'45" and longitude is 118°46'10".

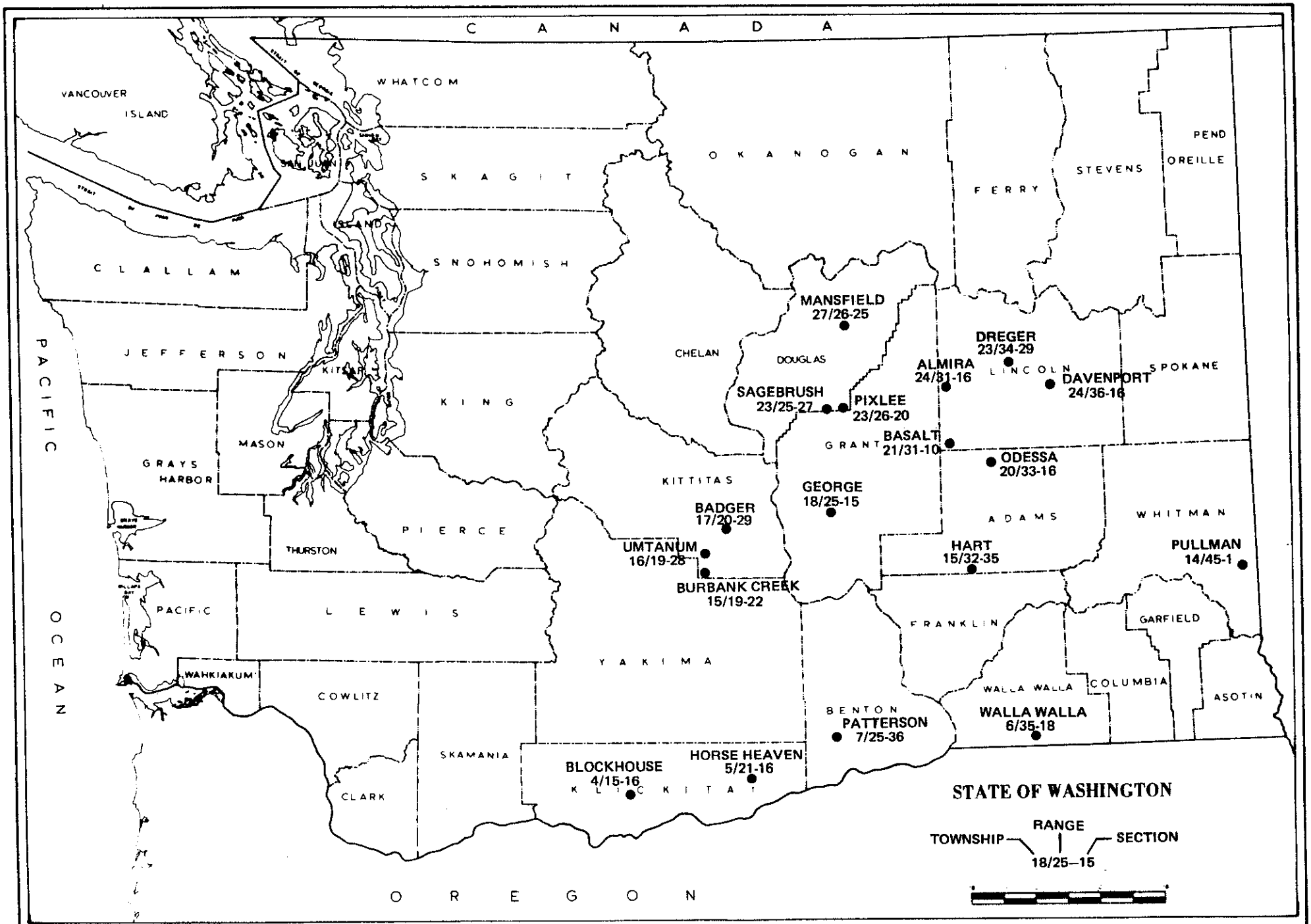


Figure 1. TEST/OBSERVATION WELLS IN EASTERN WASHINGTON.

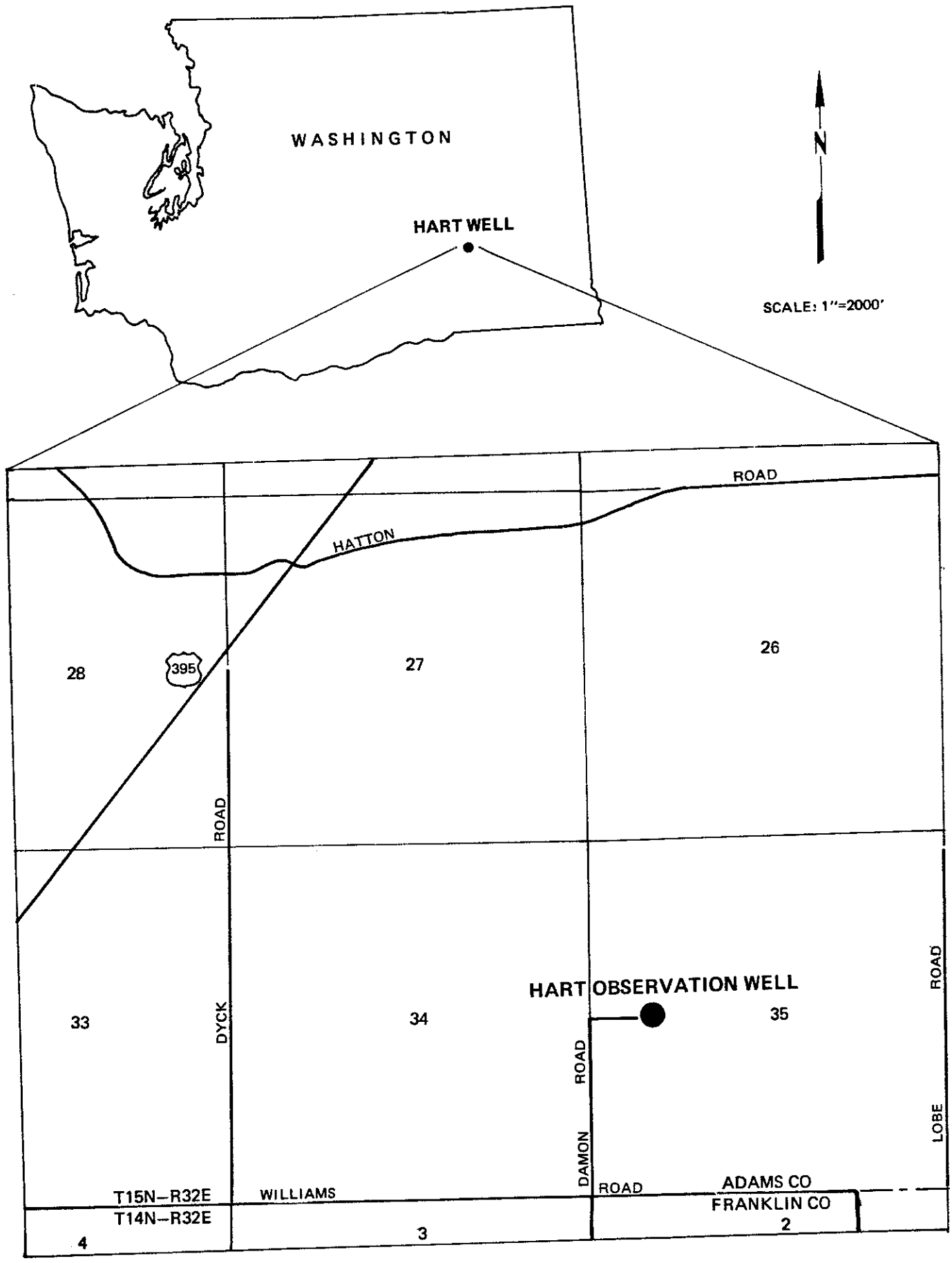


Figure 2. LOCATION OF HART OBSERVATION WELL.

The Hart observation well is in an excellent location for monitoring water levels because there are no irrigation wells within a three mile radius. Approximately seven miles to the northwest is the center of the area of greatest irrigation pumping concentration in eastern Washington and accordingly, the area of greatest ground water declines.

GEOGRAPHIC AND CLIMATIC SETTING

The well is located in the central part of the Columbia Plateau physiographic province which includes most of eastern Washington, lying east of the Cascade Mountains and south of the Spokane River.

Land surface slopes 2-5 percent to the southwest in this area. Local topography consists of low, undulating hills and draws. The climate is semiarid with an average annual precipitation of approximately 10 inches. Most of the precipitation occurs during the winter months of November through February.

A U.S. Weather Bureau station is located at Hatton, 3½ miles northwest of the well. Data from this station indicate an average annual maximum and minimum temperatures of 63°F and 37°F, respectively. Extreme summer highs reach 110°F, with extreme winter lows of -30°F. The annual mean temperature is 50°F. The average Class A pan evaporation is approximately 55 inches per year. The average annual precipitation is 9.9 inches, with an average of 0.21 inches in July and 1.3 inches in December.

GEOLOGIC SETTING

The surface soils at the well site are part of the Shano Series consisting of well-drained, medium-textured soils. Regionally, these soils generally exceed 5 feet in depth and are underlain by a lime-silica (caliche) with basalt bedrock encountered at depths of 5 to 8 feet below land surface. At this well site, the depth to basalt varies slightly from the regional conditions with caliche from 15 to 19 feet and basalt at 19 feet.

The surface of the Columbia River Basalt flow layers roughly parallel the land surface and thus are dipping 2-5 percent to the southwest. The regional stratigraphy for the Columbia Plateau has been defined by Swanson and others, 1979a as shown in Figure 3. The Saddle Mountains Formation and Mabton interbed are not found in this area.

The basalt flows penetrated by the test/observation well are part of the Yakima Basalt sequence which is known to be more than 4,000 feet thick in the area.

Water generally occurs and is transmitted in the broken, vesicular, or scoriaceous portion of individual flows. The tops of the flows generally contain vesicles, cinder and rubble which is part of the scoria, and jointing and fractures which are caused by rapid cooling of the rock. The bottoms of the flows contain baked zones and, where the flow was deposited in water, pillows of basalt occur which have interconnected cracks, joints, and/or broken zones. The centers of the flows are

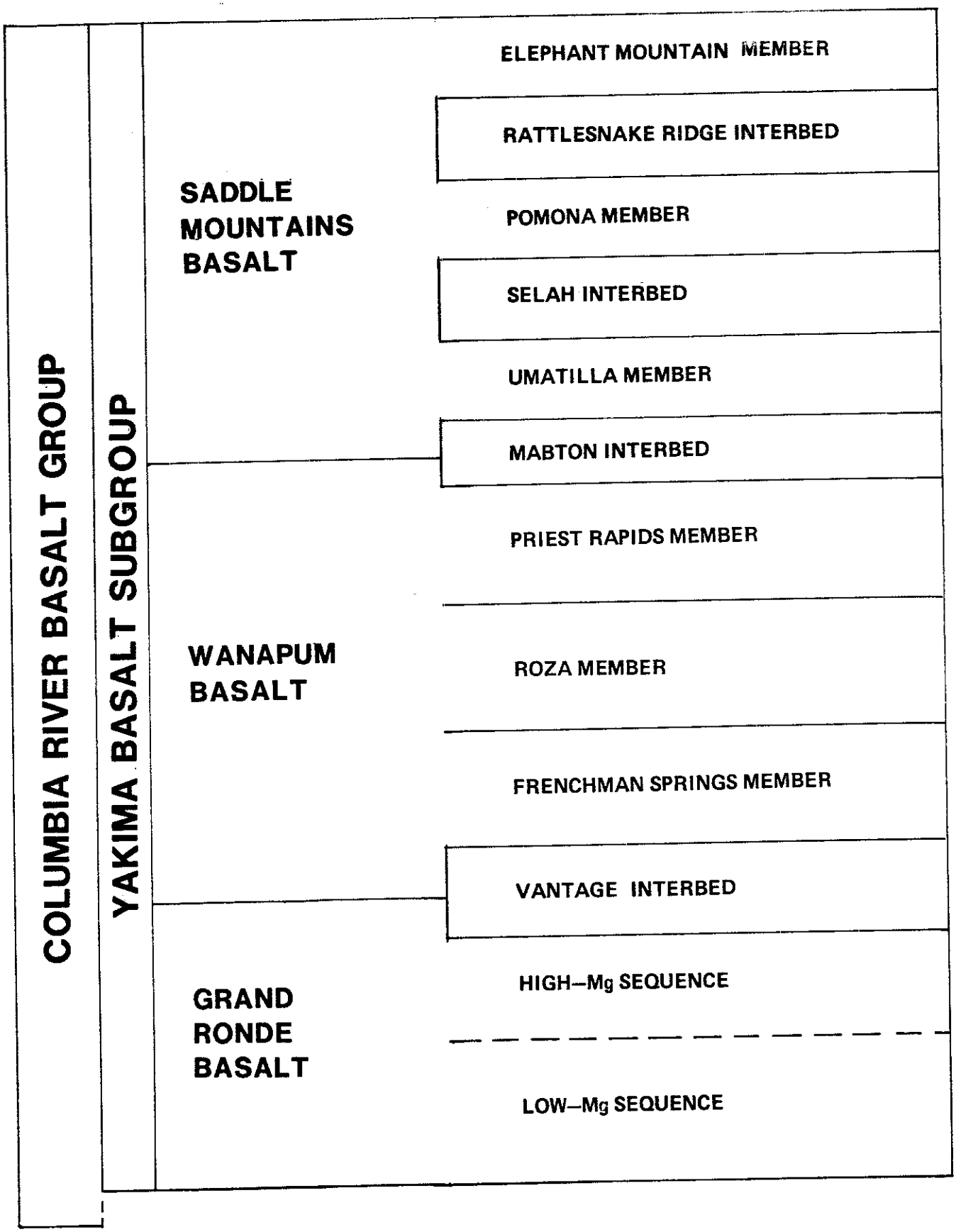


Figure 3. STRATIGRAPHIC TERMINOLOGY (AFTER SWANSON AND OTHERS, 1979a).

generally massive and contain vertical jointing caused by the shrinking of the rock during cooling; the jointing provides hydraulic interconnection between the tops and the bottoms of flows. Individual flows vary from 20 to 200 feet thick in the area near the test well.

WELL INFORMATION

CONSTRUCTION

The well was drilled by Frear Drilling of Moses Lake, Washington. Drilling was started on June 4, 1968 and completed on September 15, 1969. The well was drilled to a total depth of 1,045 feet, with 16-inch I.D. casing to a depth of 36½ feet. The remainder of the hole is 16 inches in diameter and was left uncased.

The static water level in the well at completion of drilling was 566 feet below land surface. In October 1980 (prior to installation of the piezometers), the static water level was 597.7 feet below land surface. The original well drillers report indicated a strata of unusable water at 266 feet. However, there was no further information available regarding the specific problem.

The well was drilled pursuant to Ground Water Permit No. 7579, which authorized the withdrawal of 2,000 gallons per minute for the irrigation of 1,240 acres within Sections 34 and 35, T. 15 N., R. 32 E.W.M. Upon completion of drilling, it was determined by the driller and owner that the well would not yield enough water to irrigate the proposed acreage or to even merit an aquifer test, and the project was abandoned. The permit was subsequently cancelled after the owner decided adequate ground water for irrigation was not available. The well was abandoned by cutting the casing off below ground, welding a cap on the casing and farming over the site.

LITHOLOGY

From land surface to the bottom of the well at 1,045 feet, only three lithologic units were identified by the driller, as follows:

Unconsolidated Soil	0' - 15'
Caliche	15' - 19'
Basalt	19' - 1045'

Based upon the water well report and geophysical log data, the basalt flows encountered in the Hart well from a depth of 19 feet to approximately 670 feet is the Wanapum Formation. Below the Wanapum is the Grande Ronde formation to the total depth of the well at 1045 feet. A copy of the well drillers report appears as Figure 4.

The Vantage interbed, which generally is found between the Wanapum and Grande Ronde Formations, could not be specifically identified from the driller's water well report or from the geophysical logging data.

GEOPHYSICAL LOGGING

Geophysical logging of the well by the Washington State University, consisted of a suite of logs which include the gamma gamma, neutron gamma, neutron neutron, natural gamma, caliper, fluid temperature, fluid resistivity, wall rock resistivity, and spontaneous potential.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

Figure 4. WATER WELL REPORT
STATE OF WASHINGTON

Application No 8142
Permit No. 7579

(1) OWNER: Name Cyril D. Hart Address Connell, Washington

(2) LOCATION OF WELL: County Adams SW ¼ NW ¼ Sec 35 T 15 N R 32 W M

Bearing and distance from section or subdivision corner 815 ft. east from the W¼ cor. sec. 35

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☒ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ....
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 16 inches. Drilled 1045 ft Depth of completed well 1045 ft

(6) CONSTRUCTION DETAILS:

Casing installed: 16 Diam from 0 ft to 36½ ft
Threaded ☐ Diam from ft to ft
Welded ☒ Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in by in
perforations from ft to ft
perforations from ft to ft
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No
Diam Slot size from ft to ft
Diam Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☐ No ☐ To what depth? ft
Material used in seal
Did any strata contain unusable water? Yes ☒ No ☐
Type of water? Depth of strata 266
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level 1242 ft
Static level 566 ft below top of well Date 9/15/69
Artesian pressure lbs per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes by whom?
Yield: gal./min. with ft. drawdown after hrs.
" not enough to test "
" "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min with ft. drawdown after hrs
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Soil	0	15
Caliche	15	19
Basalt-broken, black	19	36½
Basalt-black	36½	73
Basalt-gray, hard	73	143
Basalt-black, (water bearing)	143	237
Basalt-black, brown *	237	286
Basalt- black	286	346
Basalt- gray	346	411
Basalt- black	411	547
Basalt-gray, hard	547	670
Basalt- black	670	740
Basalt- gray	740	775
Basalt- gray	775	840
Basalt- black	840	893
Basalt- black, brown	893	909
Basalt- gray, hard	909	1045

* strata at 266ft. contained unusable water

Work started June 4, 1968 Completed Sept. 15, 1969

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Frear Drilling (Person firm or corporation) (Type or print)
Address Moses Lake, Washington
[Signed] J.E. Joy /S/ (Well Driller)
License No Date Sept. 18, 1969

The reader is referred to the publication by Key and MacCary (1971) as a general reference to the interpretation of geophysical logging of water wells. The logs for the Hart well were conducted to a depth of 1,000 feet, as shown in Figure 5, and reviewed with the following observations:

The caliper log shows numerous bore enlargements between 90 and 270 feet, a narrow zone at 500 feet and between 875 and 975 feet, indicating zones of less competent rock which may be porous and water bearing.

The temperature log shows a standard geothermal gradient down to about 500 feet. From 500 feet to 800 feet, the gradient is less than the geothermal increase which reflects the cooling effect of the water standing in the well. From 800 feet to the bottom of the hole, the temperature increases. The temperature at the bottom of the hole is slightly higher than normally anticipated, based upon the geothermal gradient, indicating ground water occurring in this zone.

The fluid resistivity log indicates only random moisture from 300 feet down to the static water level at 550 feet. From the static level to 875 feet there is no significant change in resistivity. From 875 feet to about 950 feet, the resistivity decreases significantly. It is noted that this zone is also where the temperature increase occurs which verifies occurrence of a water-bearing zone of differing quality than found above.

The wall rock resistivity and spontaneous potential logs indicate contact zones between basalt flows at depths of 670 feet, 770 feet, and 890 feet. The induced radiation and natural gamma logs also indicate contact zones between individual basalt flows at depths of 668 feet, 770 feet, and 885 feet. These logs also indicate progressive porosity decreases from top to bottom of each individual basalt flow. The zones of low porosity indicated on the radiation and natural gamma logs are also likely zones of low permeability and, consequently, cannot be expected to yield large quantities of ground water.

In summary, the geophysical logging data indicate that, with the exception of the upper 270 feet and 875 to 975 feet, the basalt is relatively dense, competent, and hard. The interflow zones are very thin and appear to lack weathered material or detritus which provides the high porosity and permeability through which ground water can be stored and transmitted. The deep static water level is indicative of wells completed in the Grande Ronde Formation. There does not appear to be any movement of ground water, either up or down, in the well as indicated on the temperature log.

PIEZOMETERS

Piezometers were installed to determine whether there are zones of differing head in the multiple aquifers. A piezometer is a pipe that extends from land surface to a predetermined depth in the well. The lower

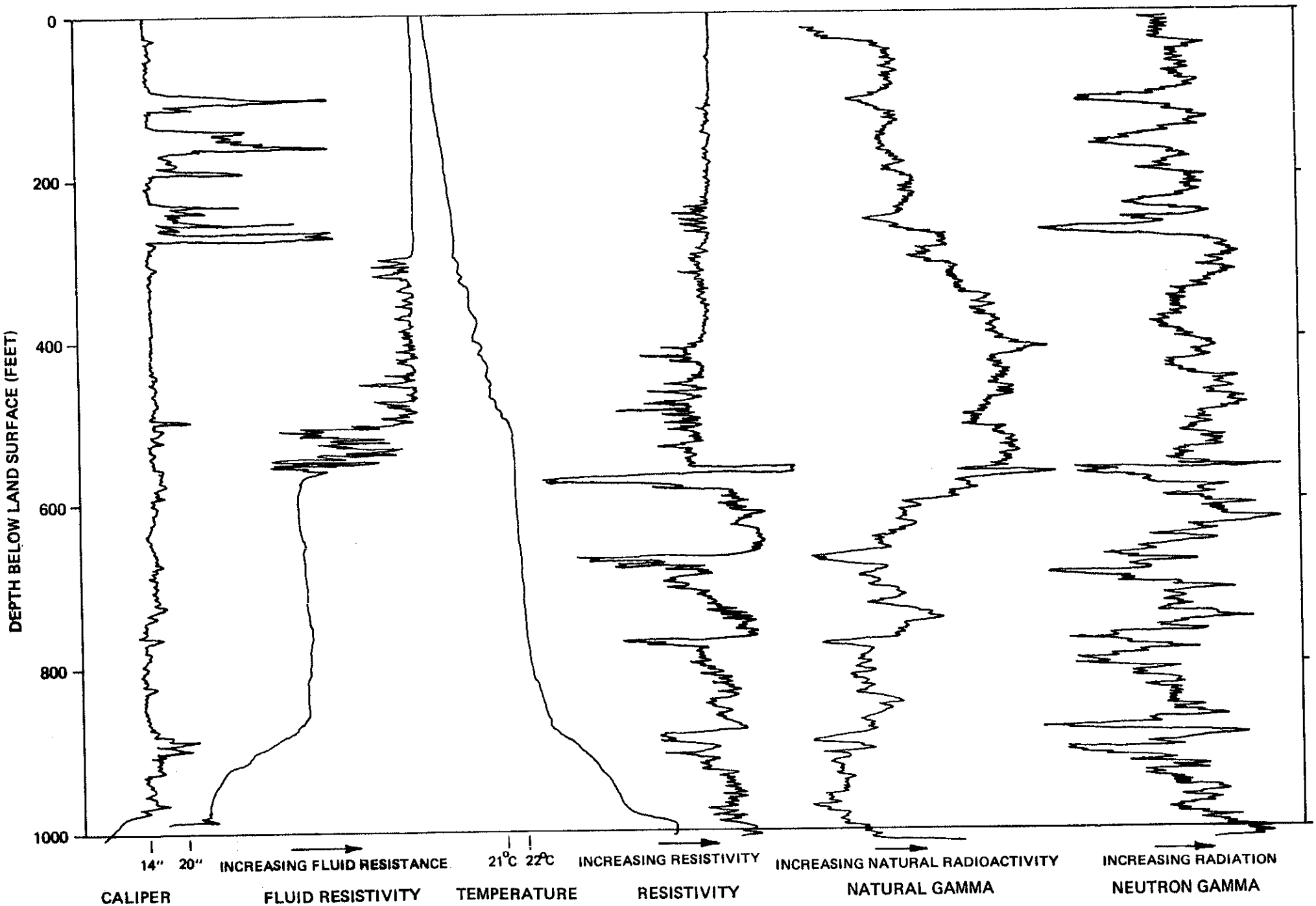


Figure 5. GEOPHYSICAL LOGS.

end of the pipe is open to a water-bearing zone within the borehole and is isolated from water-bearing zones above and below by sealing material. Each piezometer allows monitoring of the potentiometric head in the isolated zone. Without piezometers and plugs, the water level in a well represents a composite hydraulic head of all the water-bearing zones open to the well. Figure 6 illustrates the installation of the piezometers in the Hart well.

Installation of the piezometers began in June 1980. The original well casing was located below land surface, and additional casing was added so that it extended to a height of one foot above existing land surface. The depth of the well was measured at 1009 feet, indicating about 36 feet of debris had accumulated in the bottom of the hole since it was originally drilled.

It was also determined that the borehole was very crooked. Because of the crooked hole, the PVC tubing used for piezometers was difficult to install and some sections broke off during installation. Eventually, all the PVC tubing had to be pulled or drilled out. The hole was cleaned out to a depth of 966 feet. Five piezometer pipes were then installed using 1¼-inch galvanized pipe.

Details of the piezometer installation and zones monitored are as follows:

PIEZOMETER	DEPTH MONITORED	PLUG DEPTH
2	840' - 966'	825' - 840'
3	719' - 825'	699' - 719'
4	588' - 699'	573' - 588'
5	378' - 573'	362' - 378'
6	36 - 362'	

In the course of the November 1982 measurement, a steel tape broke and became lodged in Piezometer 4 and as a result no further measurements are possible.

The piezometers were also used in an attempt to extract samples for water quality analysis. Problems were encountered during sampling and a small diameter pump was lost in Piezometer 2 and 5. Piezometer 5 can still be measured, however, 2 is no longer usable. No water samples were obtained.

The water level in each piezometer was measured bimonthly by the U.S. Geological Survey Subdistrict Office in Pasco from October 1980 through December 1983. The revised schedule will reduce the occurrence of measurements to March and October annually. Water level data is presented on hydrographs in Figure 7.

Upon review of the hydrographs for the five piezometers, it becomes apparent that three piezometric head zones exist in this well. As would be expected, the piezometers monitoring the near-surface intervals, 0-362 feet and 378-573 feet, exhibit similar water levels of approximately 300 feet. The water level in the 378-573 feet interval rose significantly for the six-month period following piezometer installation, then

has fluctuated only slightly since that time. This raise reflects a stabilizing of the head in the interval monitored by this single piezometer. Lack of significant variation subsequently indicates little interference from other pumping. The near surface interval, 0-362 feet, reacted more slowly and has displayed seasonal fluctuations of up to 8 feet between January to June 1983, with subsequent variation of approximately 2 to 3 feet. Because of the distance of several miles to any major ground water withdrawals, it is suggested that the water level fluctuations reflect climatic effects rather than pumping influences.

The intermediate piezometric head zone is reflected in the well interval between 522 to 699 feet. Water levels rose approximately 50 feet between November 1980 and March 1982, then reflected a steady decline of 20 feet to October 1982. The initial rise reflects a stabilizing of the head in the interval monitored. As this depth zone is used by irrigators, the decline is believed to reflect effects of pumping at some distance. Unfortunately, it is no longer possible to obtain measurements from this piezometer.

The deep piezometric head zones are monitored between 714 to 825 feet and 840 to 966 feet. These two piezometers monitor the aquifer utilized by many of the irrigation wells situated to the northwest approximately 8 miles. The annual fluctuation of 20 to 25 feet reflects the effect of pumping. The deepest water levels occur during the late fall after all irrigation is terminated, which is a delayed response due to the distance of 8 miles to an area of intensive pumping.

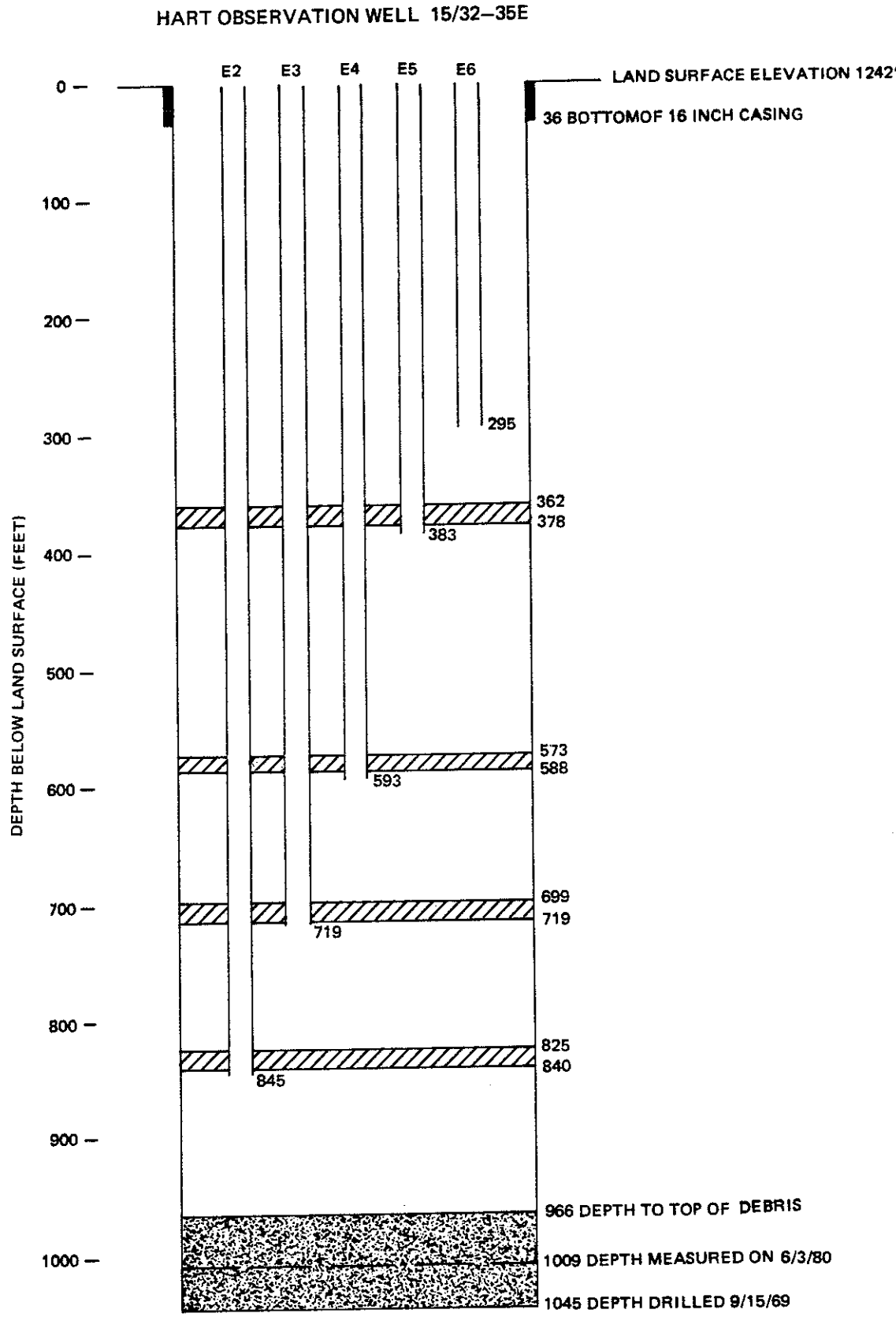


Figure 6. DIAGRAM OF PIEZOMETER INSTALLATION.

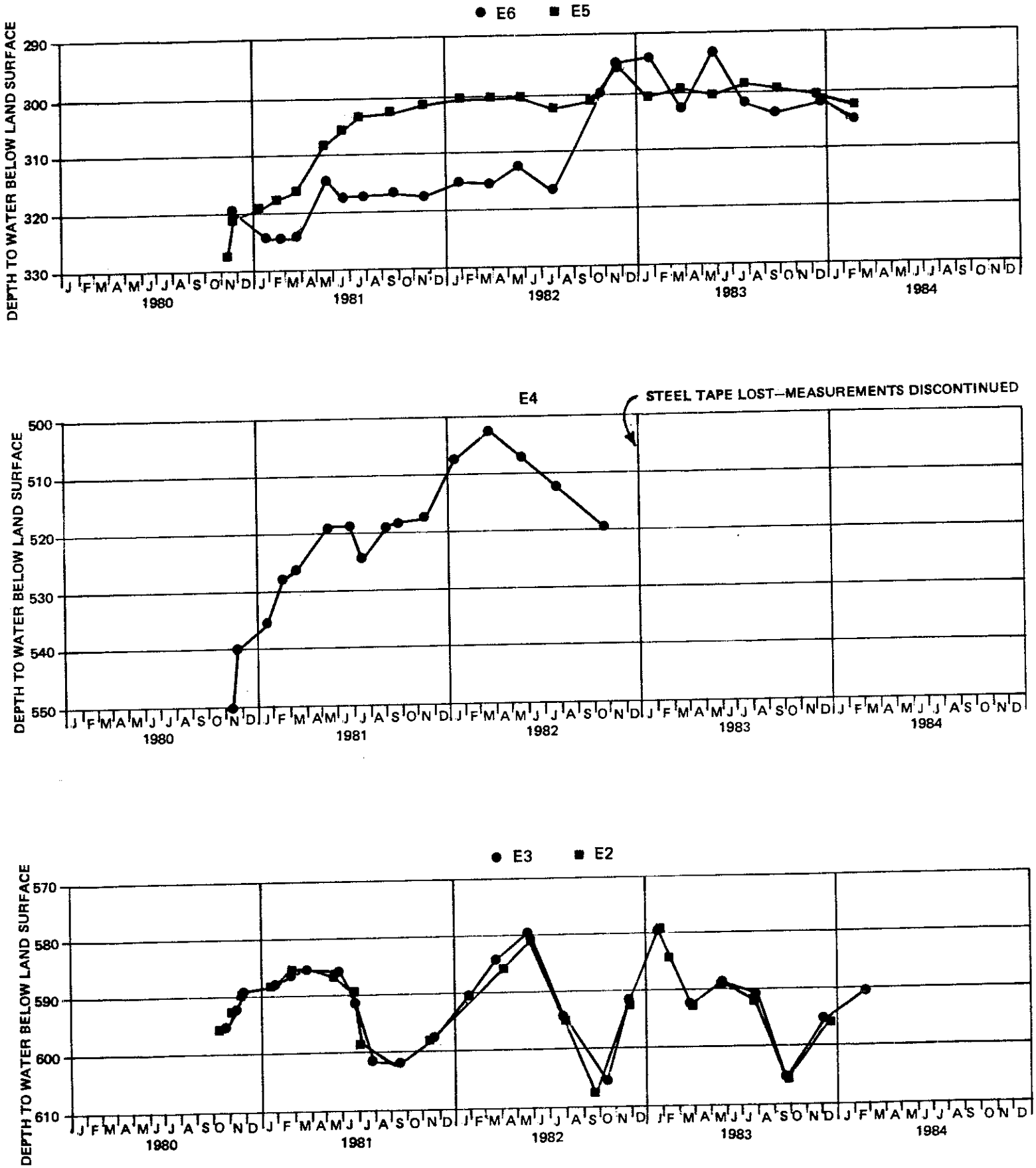


Figure 7. HYDROGRAPHS – PIEZOMETERS 2 THROUGH 6.

REFERENCE

Key, W. Scott, and Mac Cary, L. M., Application of Borehole Geophysics to Water-Resources Investigations: Techniques of Water- Resources Investigation, Book II, Chapter E-1 U. S. Geological Survey.

Swanson, D. A., Wright, T. L., Hooper, P. R., and Bentley, R. D., 1979a, Revisions in stratigraphic nomenclature of the Columbia River Basalt Group: U.S. Geological Survey Bulletin 1457-G, 59 p.

Hart/Connell Well Report

1. ~~geographic setting~~ hydrologic setting?
2. figures — ~~too~~ different location maps
3. observation well ~~figure~~ illustration, ~~must be accurate~~
4. ~~stratigraphic~~ terminology, ~~no accuracy~~
5. water well report - unreadable
6. ~~Abstract~~ - needs improvement
7. General ~~Statement~~ - needs improvement combine w/ background
8. Background - quantify; clarify point
9. ~~Geographic~~ Setting + Hydrologic setting; direction of flow recharge & discharge
10. ~~Aquifer~~ Test Section — no ~~test~~, ~~delete section~~
11. Lithology - give source
12. Logging - who will provide plates? cost?
13. Piezometer - clarify discussion
14. Water quality - who did ~~test~~, what were results?
15. Discuss hydrogeology

LOG SHEET FOR TEST WELLS

Well depth 1045, dia. 16", Hp _____, intake _____
Airline length below gage _____ (calc.) (rept.)
Mp 1 TC 1.0 ft. (+) (-) LSD
Mp 2 _____ ft. (+) (-) LSD
Mp 3 _____ ft. (+) (-) LSD

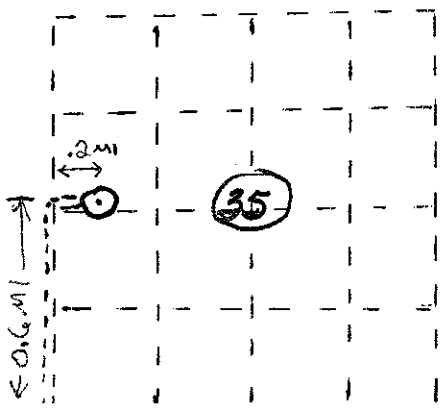
Well 15/32-35E1
County ADAMS
Owner HART
OBS. WELL
USGS: 547-2571

Status: ____off, A ppg, B ppd, rec., C nrby. ppg., D nrby, ppd. rec., F dry
Type: T Steel (rec. to 0.01 ft.), elec. or logger (rec. to 0.1 ft.), airline or head above LSD (rec. to nearest foot), D drilling, G reported
Note: Measure airline pressure only with USGS gage and only when no other way

PIEZOMETER (SPO. D.O.E. HAS KEY TO WELL LOCK

Date	Airline PSI	Tape or Airline Measurement Length	Subm.	Water Level Below Mp	Below LSD	Status	Mp	Water Temp.	Meas. By	Remarks
1/29/81	E-2			588.4					USGS	PASCO OFFICE USGS
	E-3			588.6						MEASURES THIS WELL
	E-4			545.5						ON 8 WK INTERVALS
	E-5			319.2						
	E-6			324.7						
3/30/82	E-2			585.6					USGS	
	E-3	"		584.1						
	E-4			512.1						
	E-5			300.3						
	E-6			315.6						
3/31/83	E-2	703.25	-120.0	583.25	583.25					
	E-5			300.25	299.25					
	E-6			306.25	305.25					
3/28/83	E2			592.15					USGS	
	E3			592.9						
	E4	TAPE	LOST IN	HOLE						
	E5			293.X						
	E6			302.51						

Location and Instructions



E2 MONITORS 840 – 1045
E3 714 – 825
E4 588 – 699
E5 378 – 573
E6 0 – 362

ECY 040-1-89

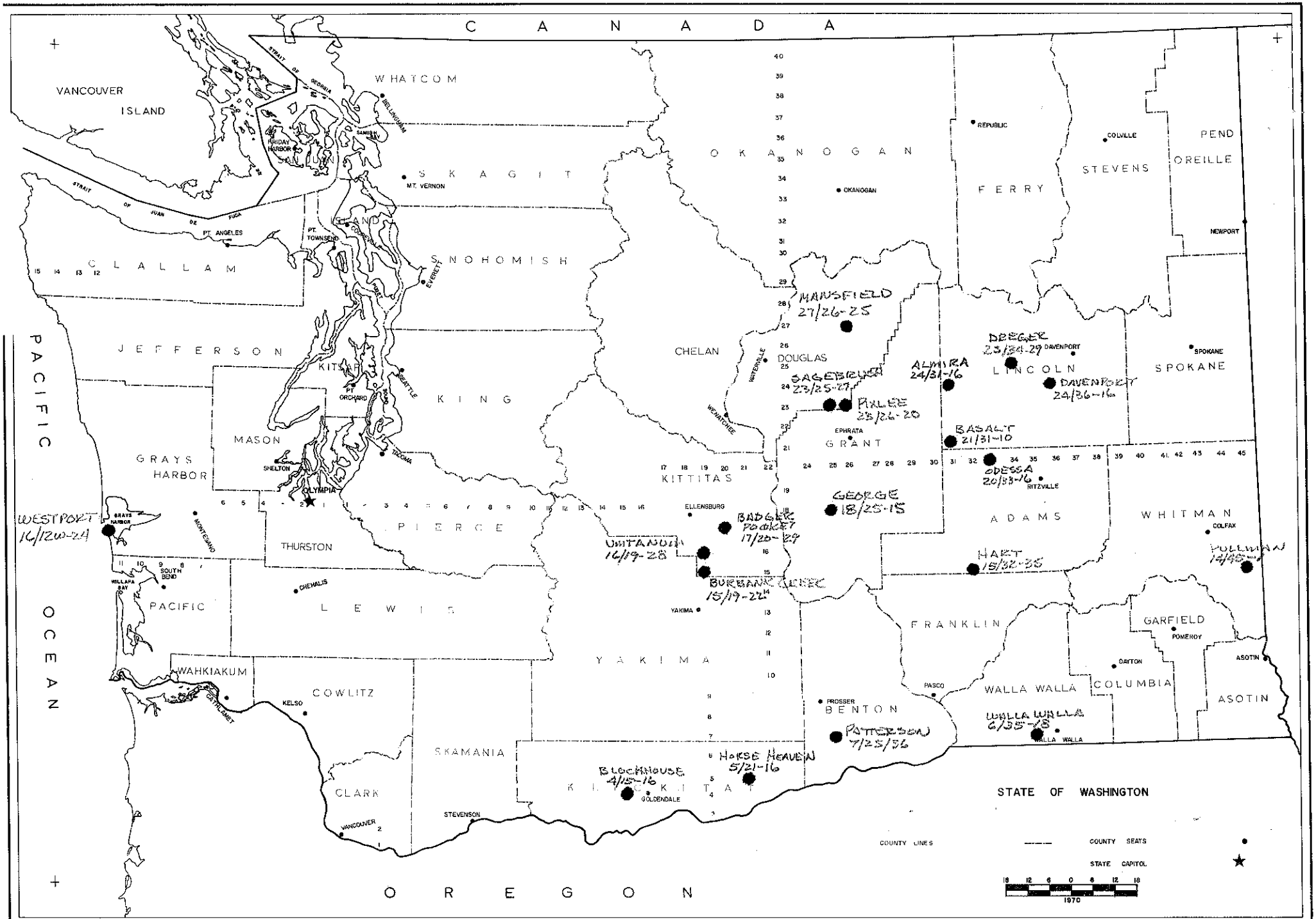


FIG 1. TEST/OBSERVATION WELLS IN EASTERN WASHINGTON

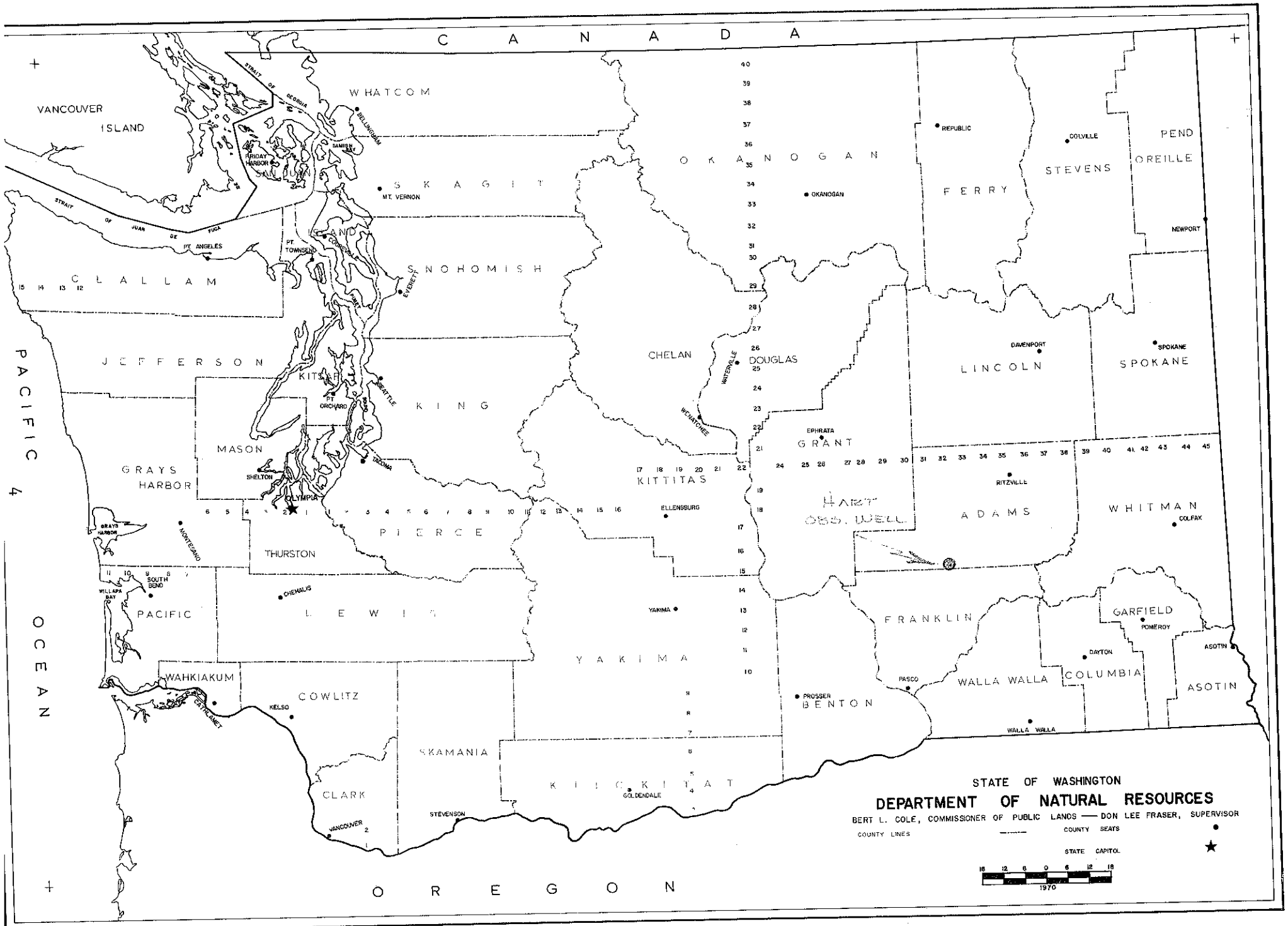


Fig 2: Location of Hart Observation Well in Washington

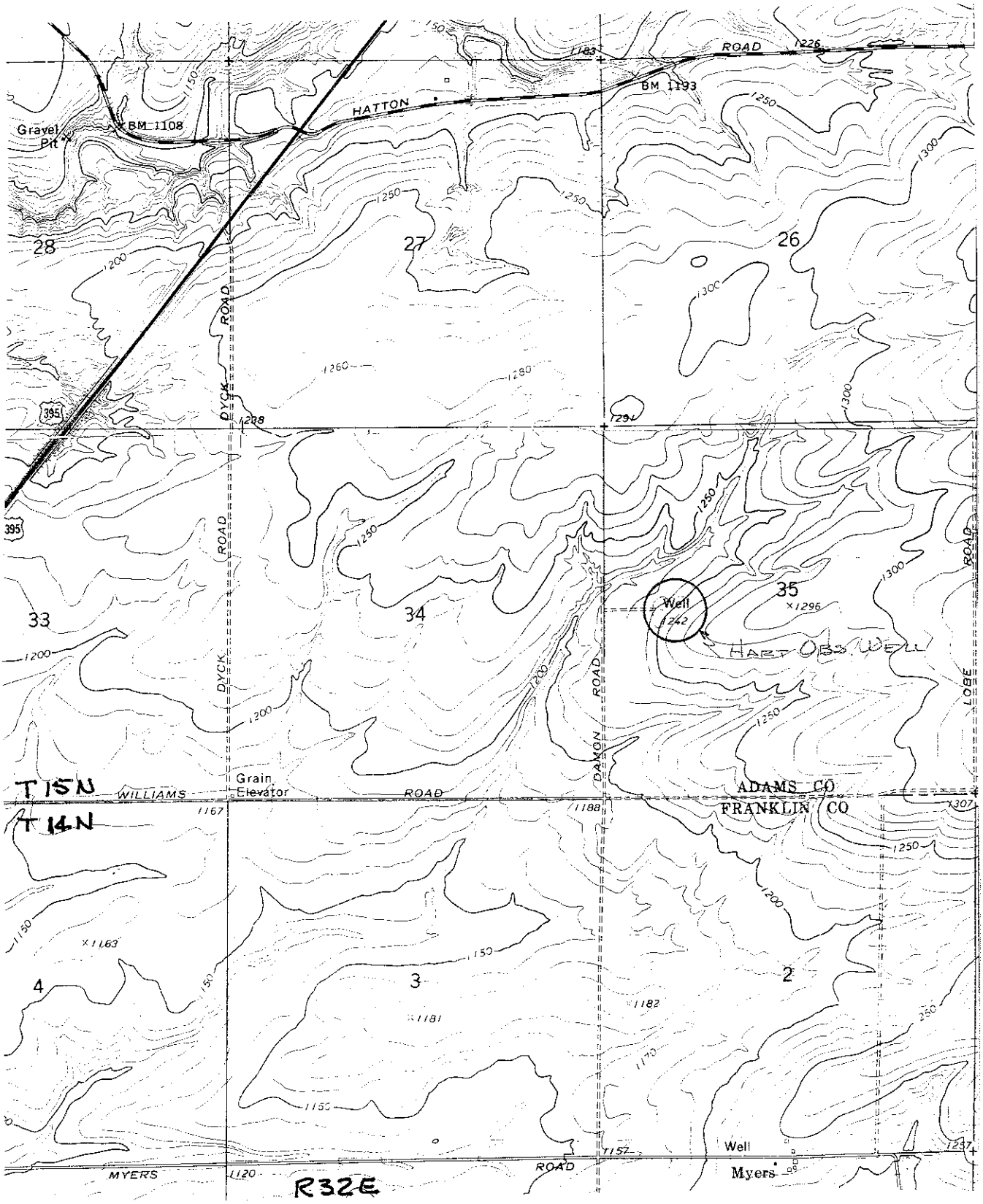


Fig 3 Detailed location
Hart Observation Well

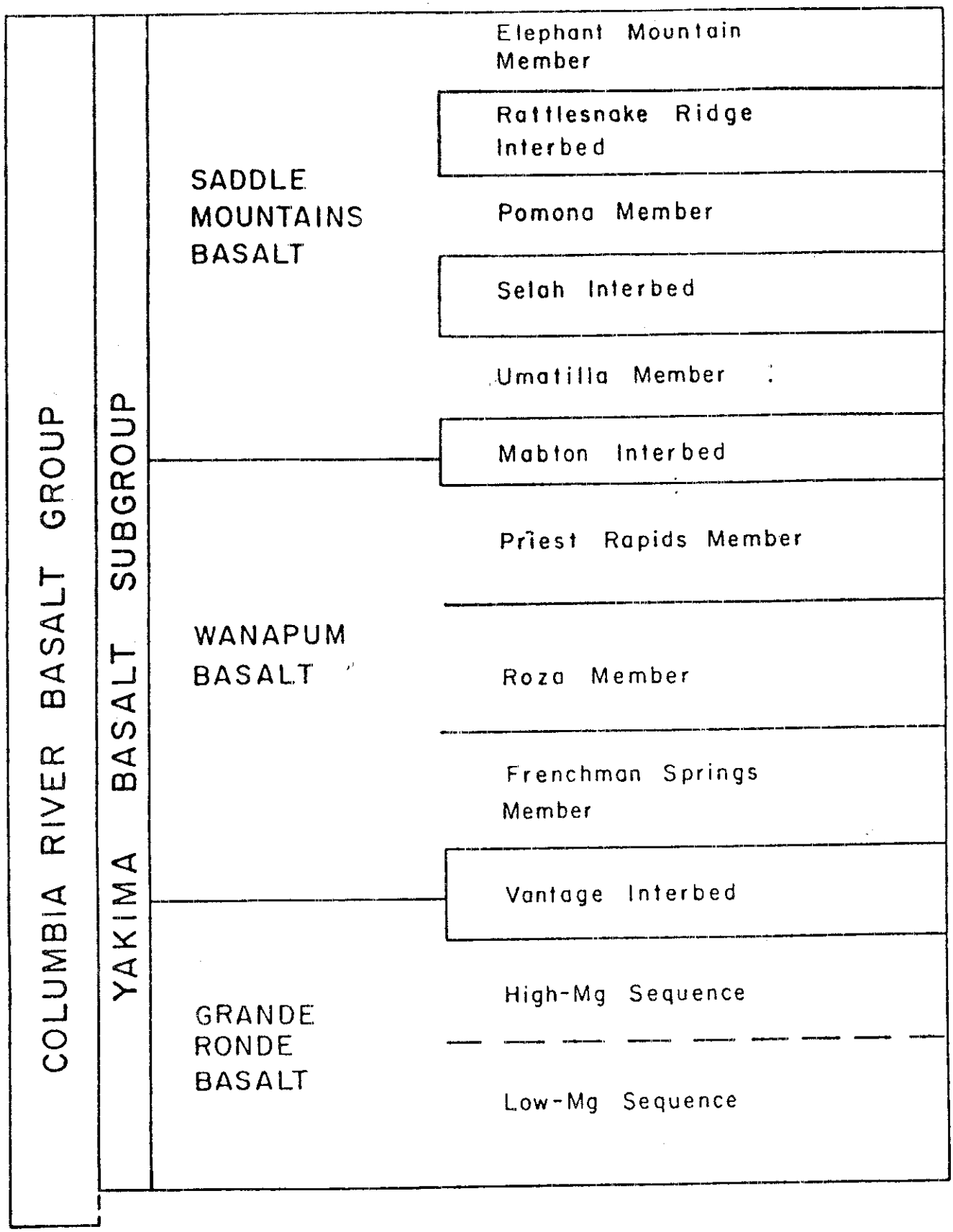


Figure 4. Stratigraphic terminology used in this report (after Swanson and others, 1979a)

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No 8142

Permit No. 7579

(1) OWNER: Name Cyril D. Hart Address Connell, Washington

(2) LOCATION OF WELL: County Adams — SW ¼ NW ¼ Sec 35 I 15 N R 32 WM

Bearing and distance from section or subdivision corner 815' east from W¼ cor. sec. 35

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 16 inches.
Drilled 1045 ft Depth of completed well 1045 ft

(6) CONSTRUCTION DETAILS:

Casing installed: 16 Diam. from 0 ft to 36½ ft.
Threaded ☐ Diam from ft to ft
Welded ☒ Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in by in
perforations from ft. to ft
perforations from ft to ft
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No
Diam Slot size from ft to ft
Diam Slot size from ft to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☐ No ☐ To what depth? ft
Material used in seal
Did any strata contain unusable water? Yes ☒ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level 1242 ft
Static level 566 ft below top of well Date 9/15/69
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min with ft. drawdown after hrs.
Not enough to test
" "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min with ft drawdown after hrs
Artesian flow g p m Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Soil	0	15
Caliche	15	19
Basalt, broken, black	19	36½
Basalt, black	36½	73
Basalt, gray, hard	73	143
Basalt, black (water)	143	237
Basalt, blask, brown	237	286
Basalt, black	286	346
Basalt, gray	346	411
Basalt, black	411	547
Basalt, gray, hard	547	670
Basalt, black	670	740
Basalt, gray	740	775
Basalt, gray	775	840
Basalt, black	840	893
Basalt, black, brown	893	909
Basalt, gray, hard	909	1045

Work started June 4, 1968 Completed Sept. 15, 1969

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief

NAME Frear Drilling (Person, firm, or corporation) (Type or print)

Address Moses Lake, Washington

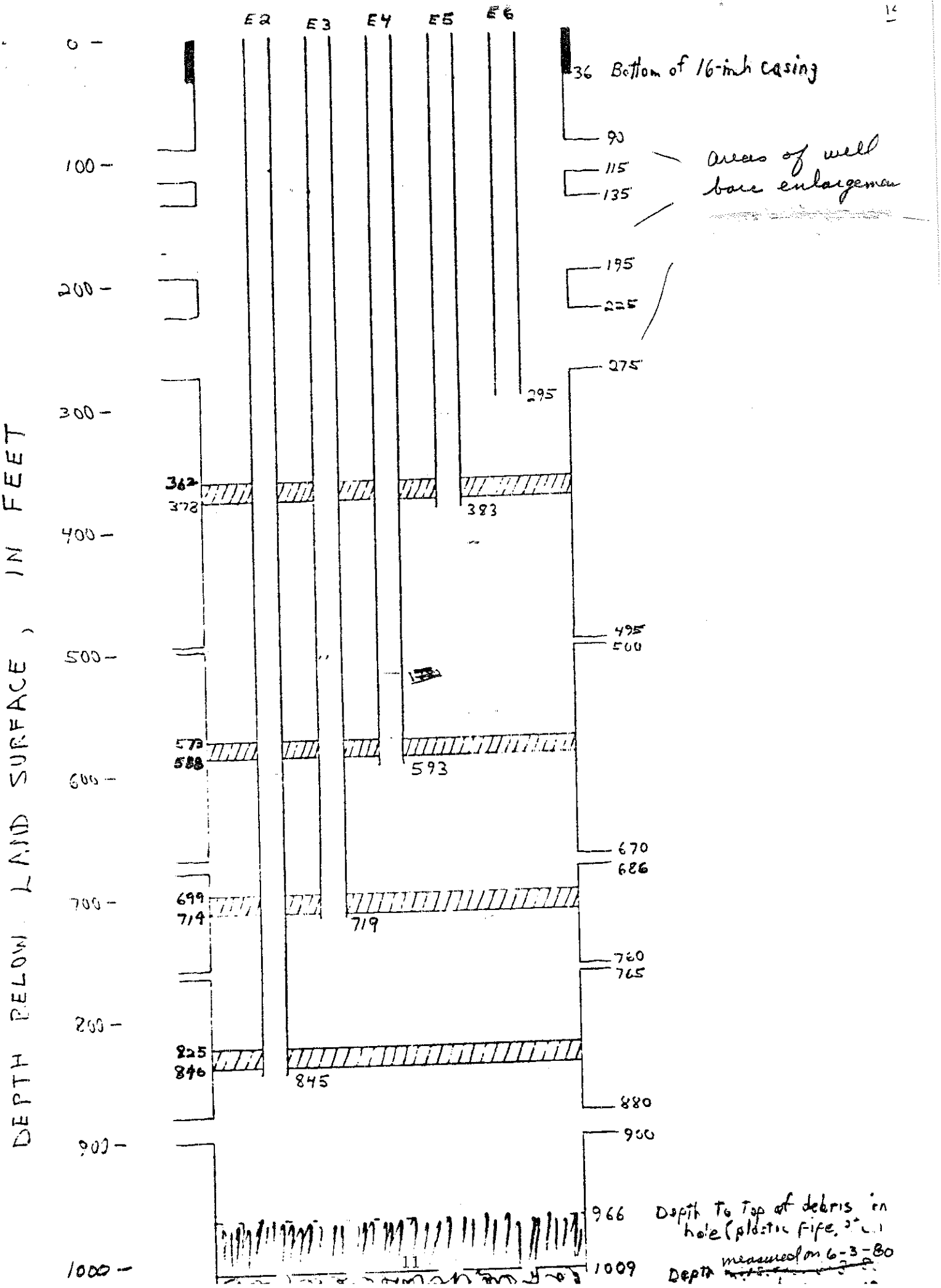
[Signed] J. E. Joy /S/ (Well Driller)

License No Date Sept. 18, 1969

9

(USE ADDITIONAL SHEETS IF NECESSARY)

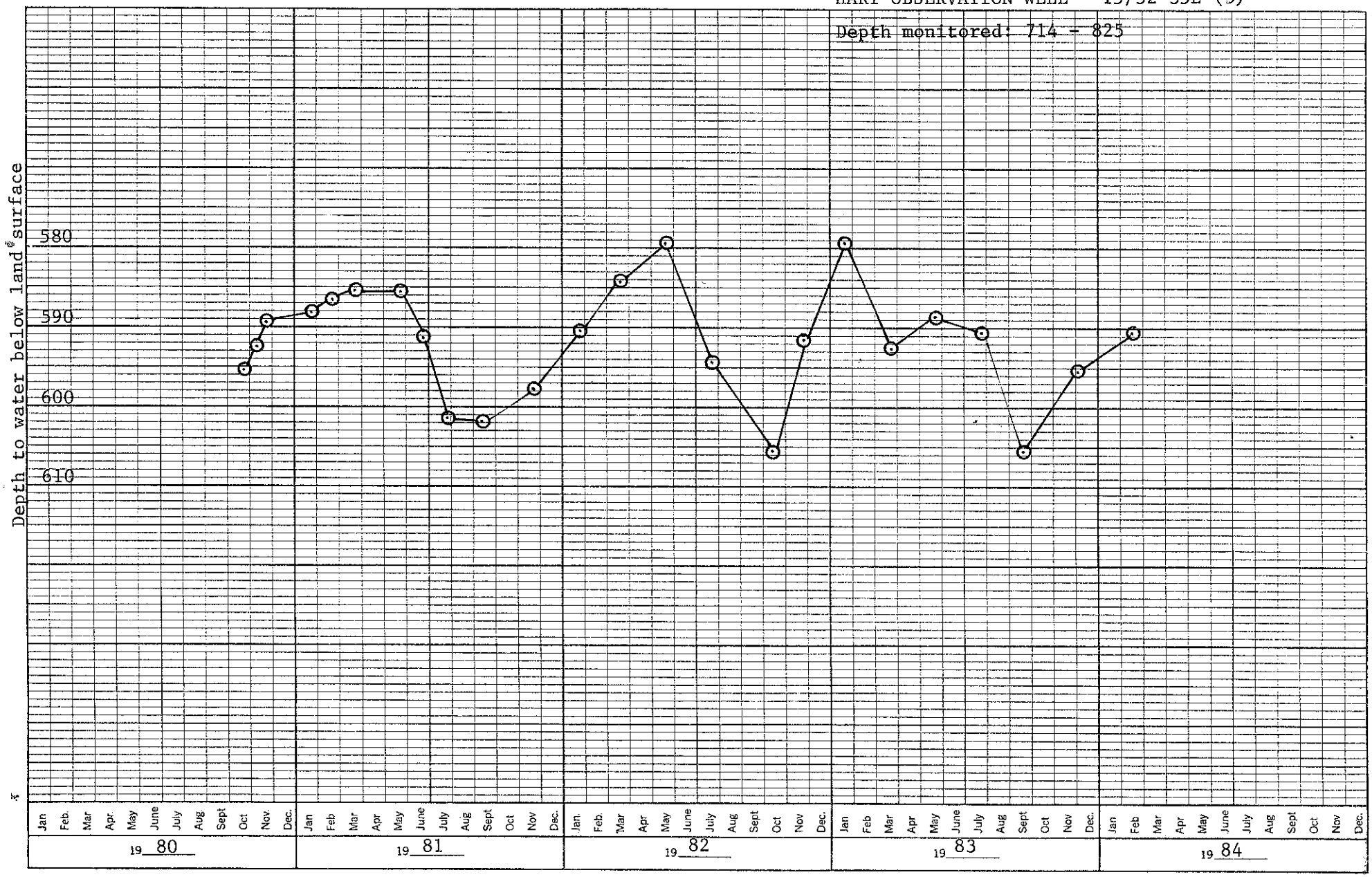
ECY 050-1-20


E2
E3
E4
E5
E6
36 Bottom of 16-inch casing
90
115
135
195
225
275
295
Areas of well bore enlargeme
362
378
383
495
500
573
588
593
670
686
699
714
719
760
765
825
846
845
880
900
966
1009
Depth To Top of debris in hole (plastic pipe, 3" D
Depth measured on 6-3-80
0
100
200
300
400
500
600
700
800
900
1000
DEPTH BELOW LAND SURFACE, IN FEET

46 3653

HART OBSERVATION WELL 15/32-35E (3)

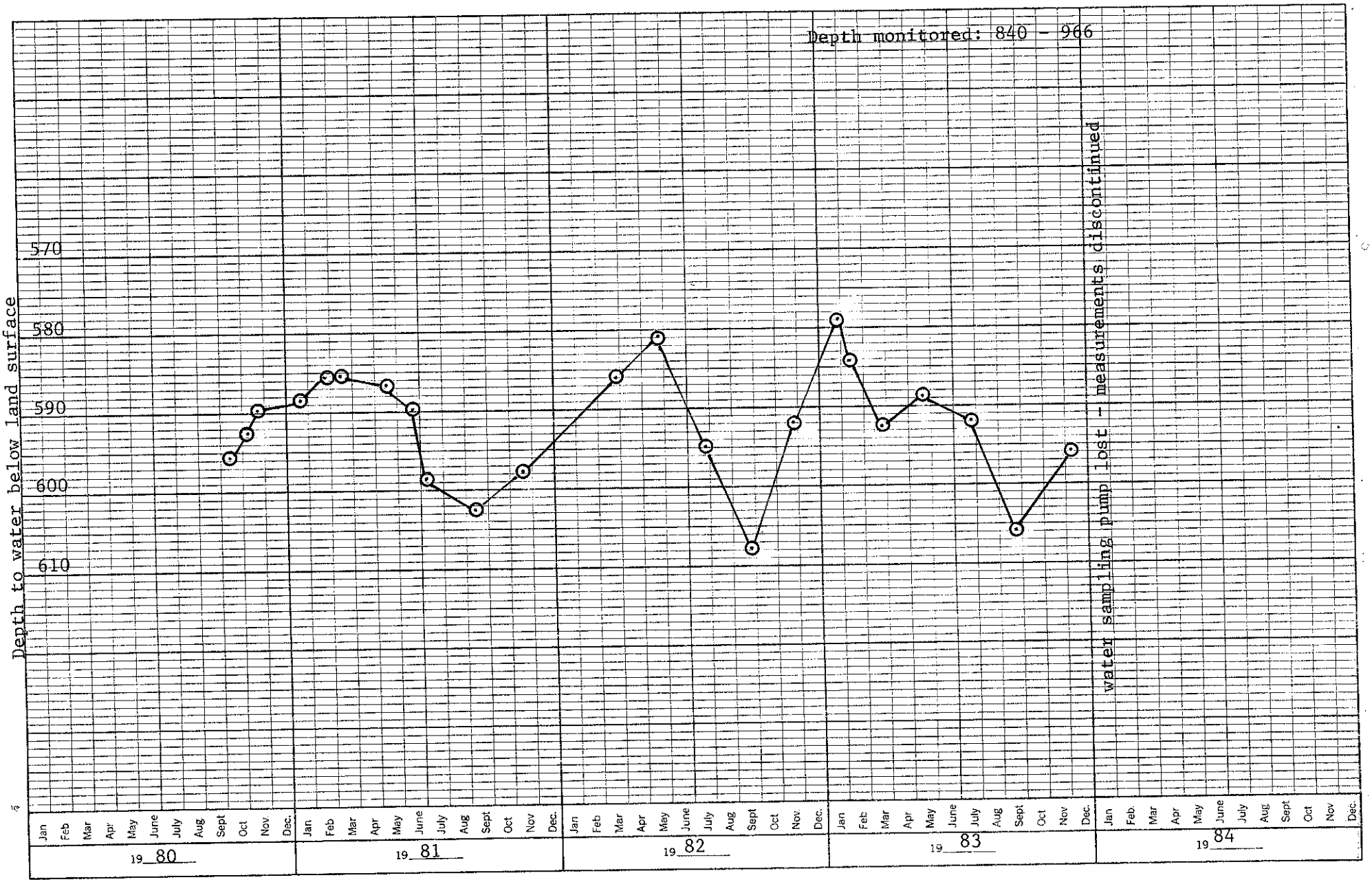
Depth monitored: 714 - 825



K+E 5 YEARS BY MONTHS X 100 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

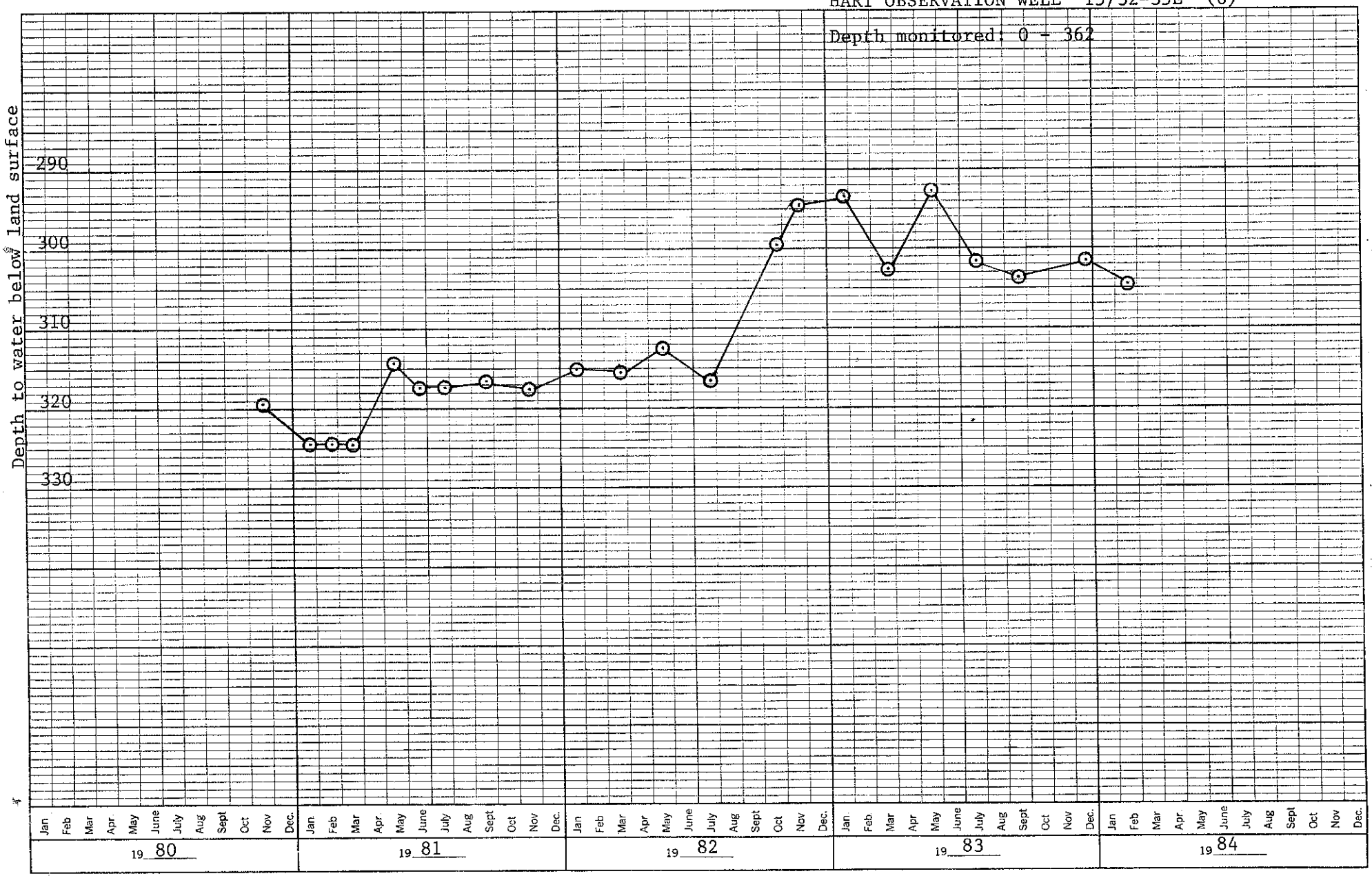
46 3653

HART OBSERVATION WELL 15/32-35E (2)



HART OBSERVATION WELL 15/32-35E (6)

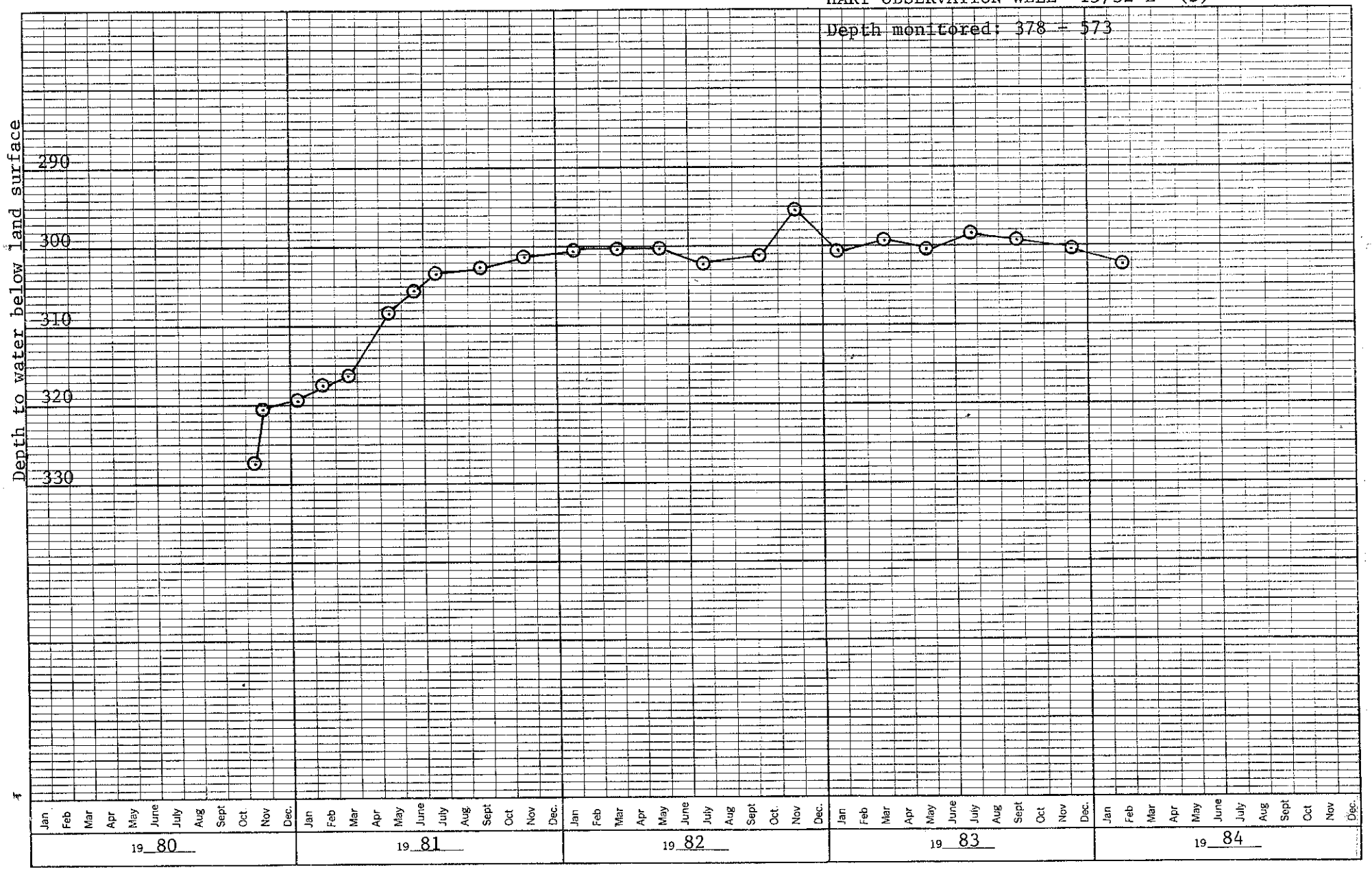
Depth monitored: 0 - 362



46 3653

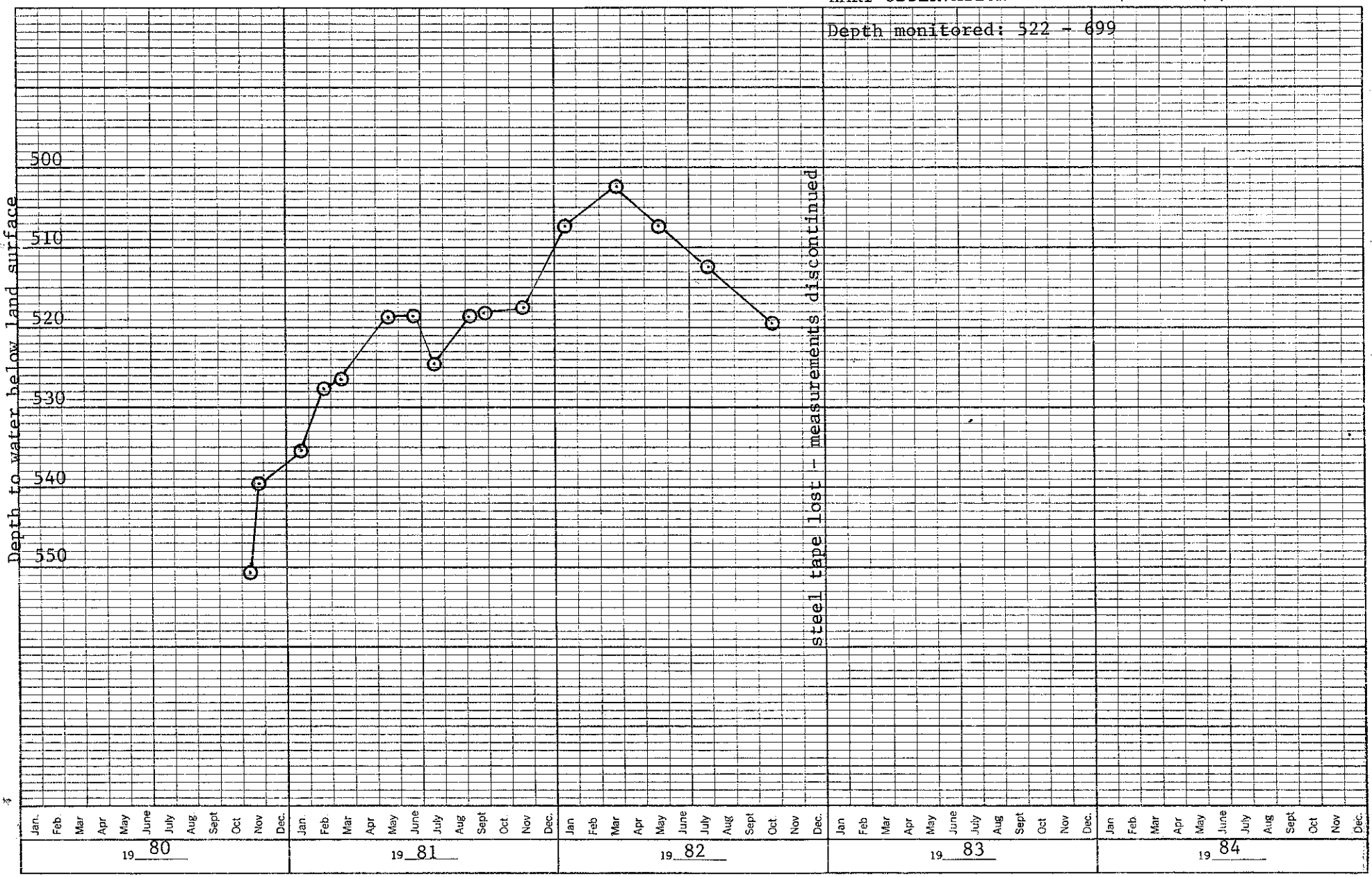
HART OBSERVATION WELL 15/32-E (5)

Depth monitored: 378 - 573



HART OBSERVATION WELL 15/32-E (4)

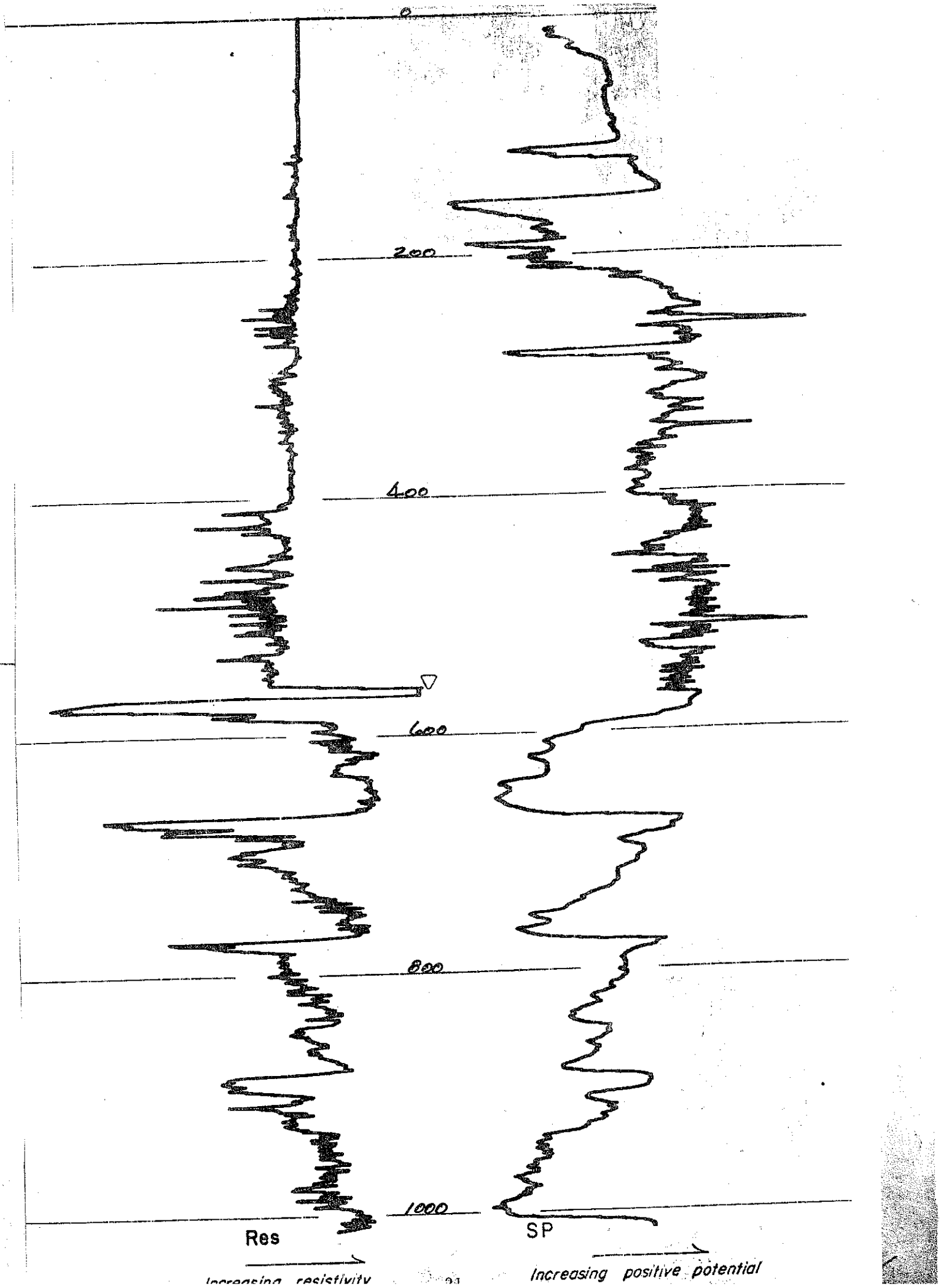
Depth monitored: 522 - 699

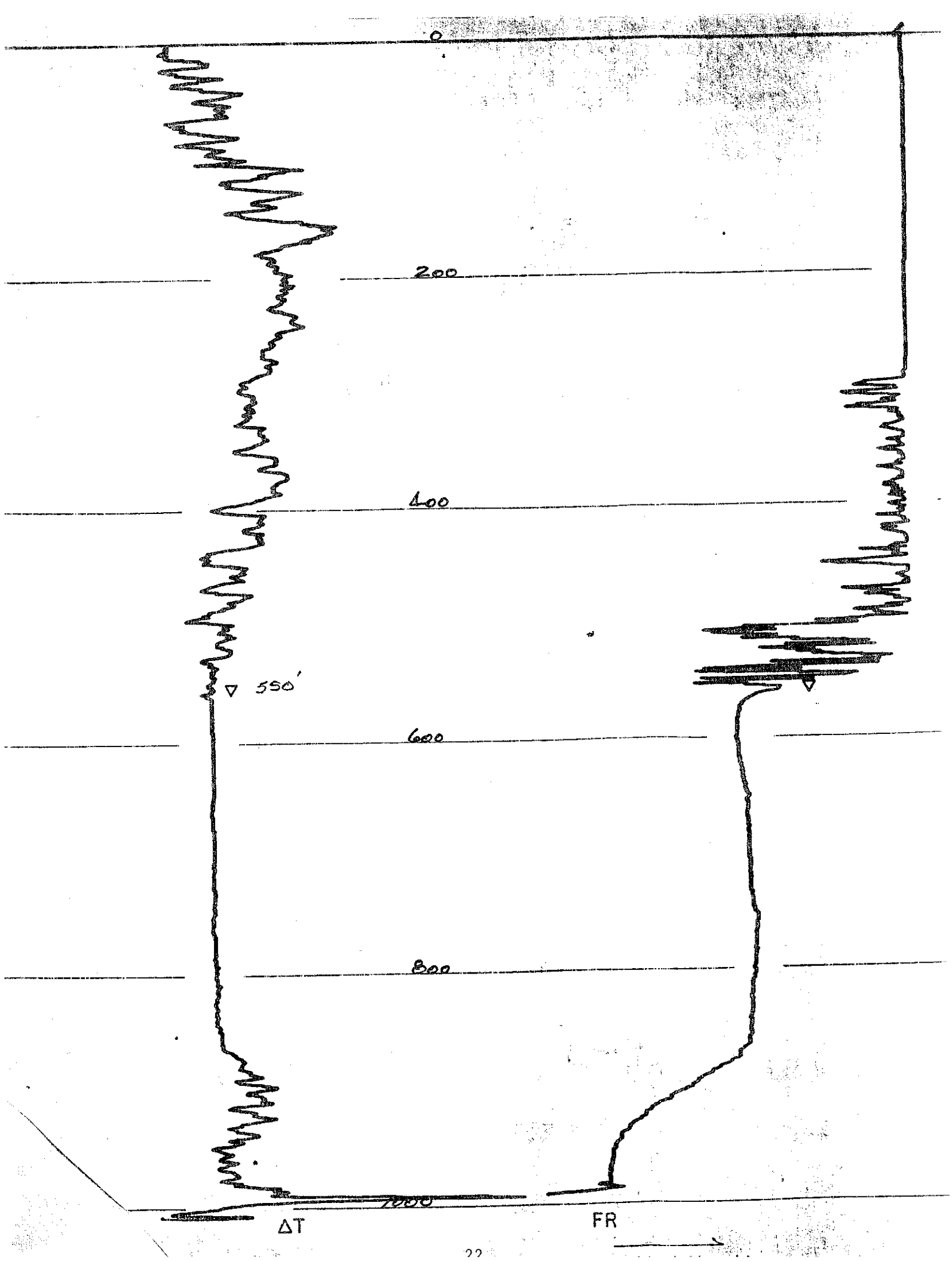


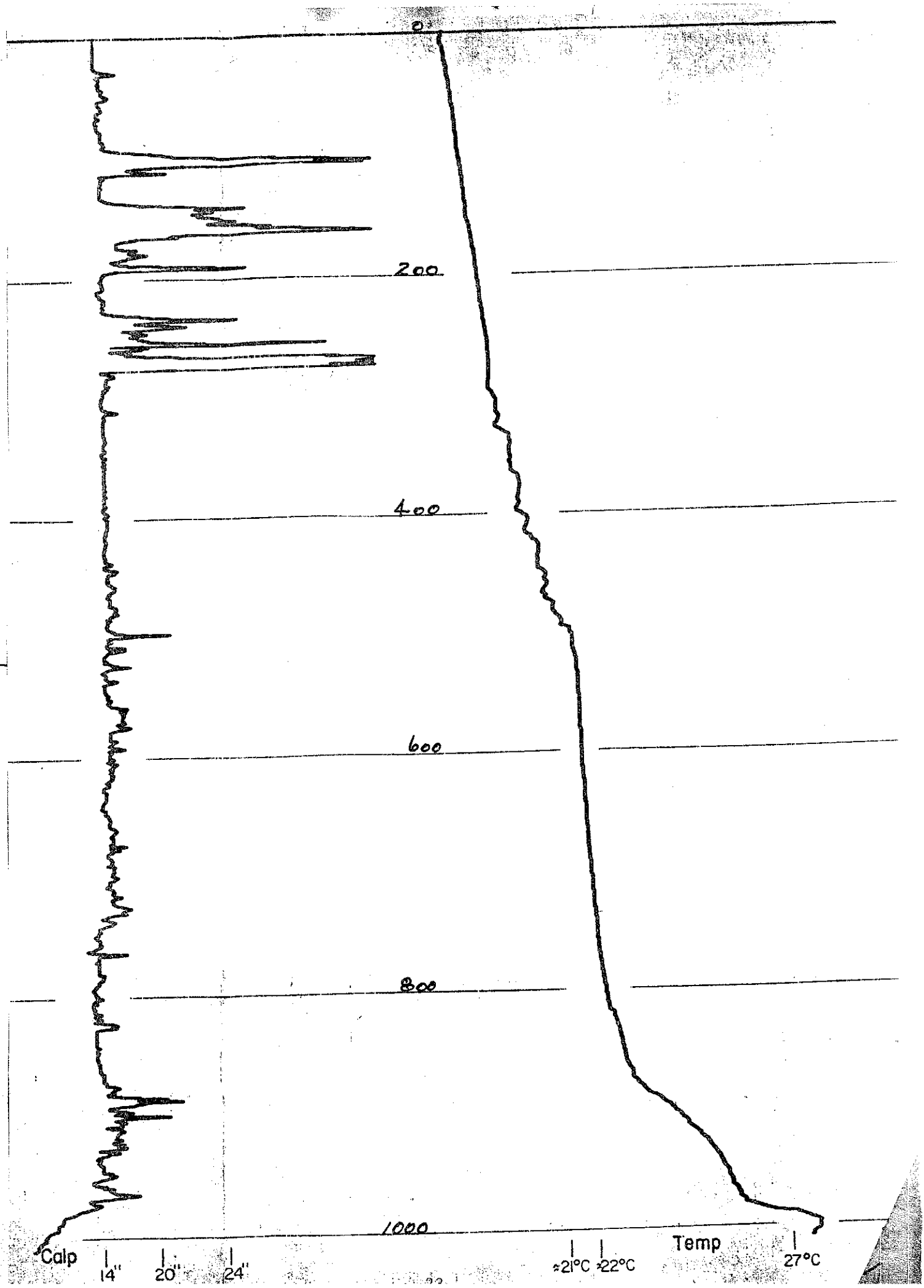
APPENDIX

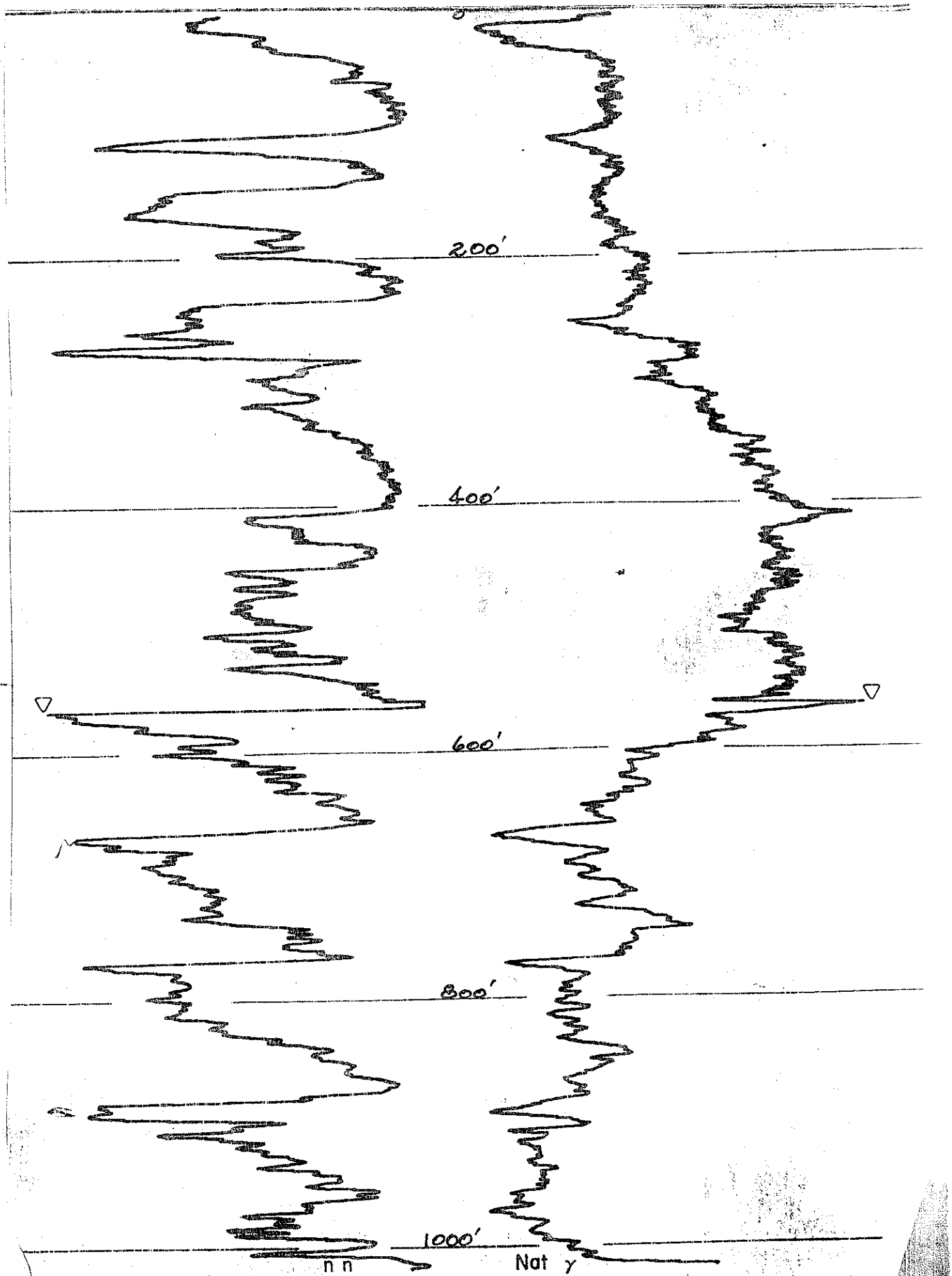
GEOPHYSICAL LOGS

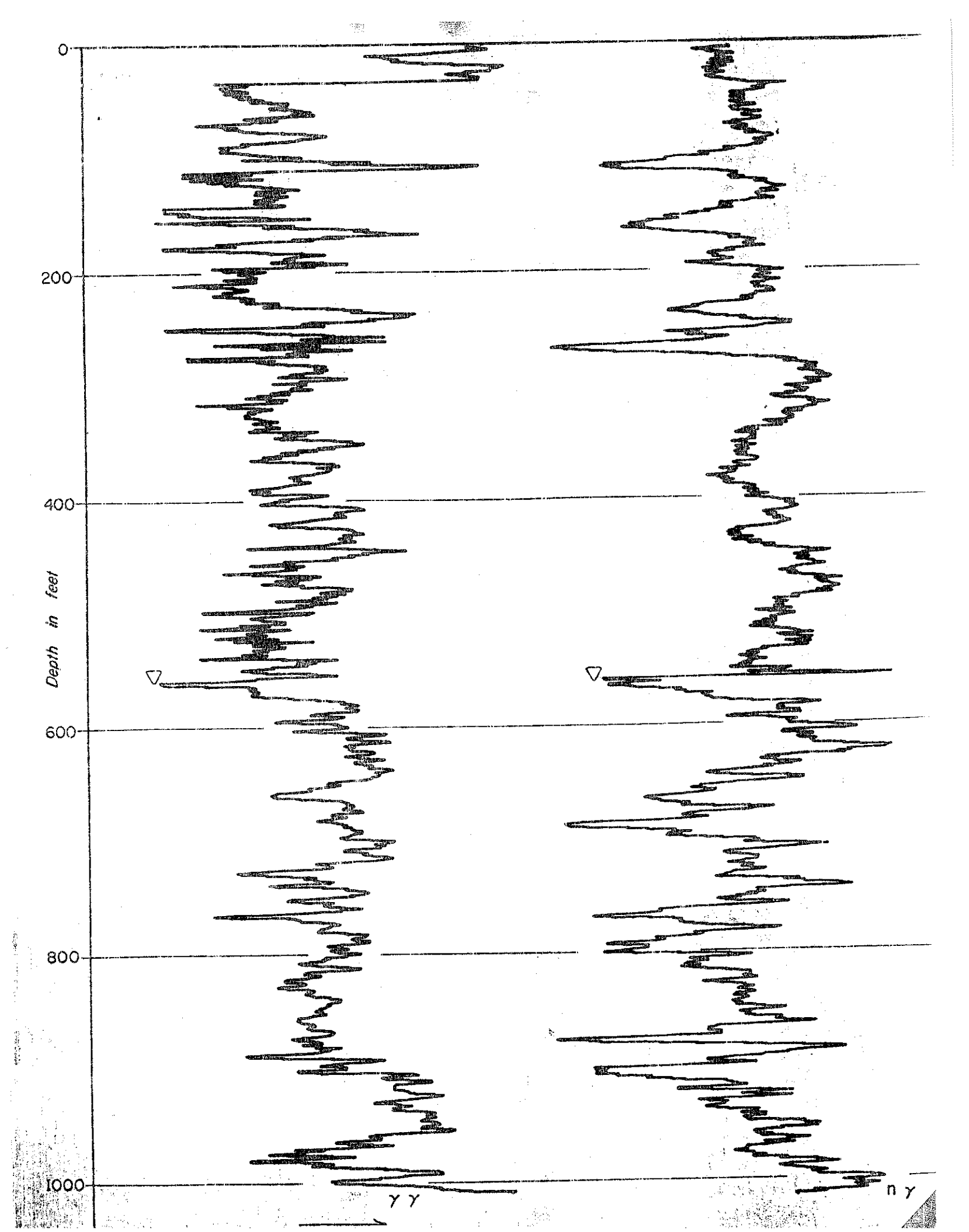
Gamma Gamma
Neutron Neutron
Caliper
Fluid Temperature
Resistivity
Neutron Gamma
Natural Gamma
Temperature
Fluid Resistivity
Spontaneous Potential


0
200
400
600
800
1000
Res
SP
Increasing resistivity
Increasing positive potential


0
200
400
550'
600
800
1000
ΔT
FR


0
200
400
600
800
1000
Calp
14"
20"
24"
Temp
≈21°C
≈22°C
27°C


200'
400'
600'
800'
1000'
n n
Nat γ
Increasing porosity
Increasing natural radioactivity


0
200
400
600
800
1000
Depth in feet
γ γ
n γ